SPECIFICATION

TITLE OF THE INVENTION

NETWORK-DEVICE CONTROL SYSTEM AND APPARATUS

BACKGROUND OF THE INVENTION

5   This invention relates to a system and apparatus for controlling network devices. More particularly, the invention relates to a network-device control system and apparatus for performing control of priority, bandwidth, discard rate and delay in relation the devices that

10   construct a network.

The following functions and features (1) to (3) are currently sought as network requirements:

(1) Quality assurance

Unification of continuous traffic, such as

15   telephone traffic that is sensitive to delay, and basic business traffic with an IP (Internet Protocol) network of superior cost performance is sought. However, the basic nature of an IP network is best-effort transport of IP packets. In such a best-effort transport

20   environment, an effort is made only to transport arriving packets to the next stage without distinguishing among users or among applications. Packets that cannot be transported (i.e., packets for which buffer overflow has occurred) are discarded as is.

25   Accordingly, in order for a best-effort IP network to accommodate delay-sensitive traffic, it is required that control of traffic priority and assurance of bandwidth based upon the user or application is introduced in an

IP network.

    (2)   Minimum modification of existing network

            devices

    Replacing terminal devices and network devices

5   (routers, switches, etc.) and installing new software in

these devices in order to assure bandwidth and control

priority on a network raises the cost of introduction

and, hence, is a hindrance to such introduction.

Minimizing the modification of existing devices is

10   required in order to solve this problem.

    (3)   Quality and priority control capable of

            dealing with dynamic modification of

            terminal devices and network devices

    Among all devices that construct a network, it will

15   suffice to apply quality and priority control solely to

end-to-end devices on the communication path. This

communication path is decided in accordance with a

predetermined routing protocol based upon the

destination address with which communication is

20   performed and the terminal address of the accessing

party. However, the destination address and terminal

address change constantly depending upon the location of

the user and the application utilized. A dynamic

quality and priority control method that can deal with

25   such change is sought.

    The following two methods have been contemplated

for the purpose of performing quality assurance control

such as control for assurance of bandwidth or control of

priority.

The first method involves statically configuring network devices for the purpose of quality-assurance control. Specifically, control of communication quality

5 with respect to terminal-to-terminal communication is performed by configuring the network devices before hand so that predetermined bandwidth assurance and priority control is attained. This is the most widely utilized approach at present. In order to configure for

10 bandwidth assurance and priority control (i.e., in order to establish control of quality), there are two methods, namely (a) a method referred to as limited configuration method which includes predicting communication that will occur and configuring network devices on this

15 communication path for control of quality in limited fashion, and (b) a method which includes configuring all configurable network devices for control of quality comprehensively without particularly specifying a path.

The second method uses an RSVP (Resource

20 Reservation Protocol) for which control of quality can be configured dynamically. RSVP is a control protocol for reserving resources in the IP layer. According to RSVP, control messages are exchanged between routers that support RSVP and the sender and receiver. The RSVP

25 works to reserve transmission paths and memory resources within an apparatus so that an application can be executed. Fig. 20 is a diagram useful in describing RSVP. A sender 1 sends a receiver 2 a path message that

describes the traffic characteristics of the information (content) to be transmitted. The path message is distributed to the receiver 2 by being transferred along a path (routers 3, 4) set up by a predetermined routing

5 protocol. The receiver 2 refers to the content described in the path message and sends a reserve message, which describes the resources requiring reservation, back to the sender 1. If reservation requests from a plurality of receivers are merged and

10 acceptance of a requested bandwidth reservation is possible in a router along the path, bandwidth is secured in accordance with the content of the reservation request and a reserve message is transferred to a router upstream and to the sender 1. If acceptance

15 of a requested bandwidth reservation is impossible, however, the reserve message is discarded and an error message is transmitted to the receiver 1.

The second method based upon RSVP described above makes it possible to control quality dynamically when

20 the user so desires.

However, the first and second methods set forth above do not always satisfy the above-mentioned requirements (1), (2) and (3).

If communication different from that predicted in

25 advance takes place, as when a user makes access from a terminal different from that configured beforehand or when a network device is added on anew, the limited configuration technique according to the first method is

such that static quality-control settings will not exist

for such communication. This means that the required

control of quality cannot be performed. In other words,

with the limited configuration method, changes in

5   conditions cannot be dealt with and, as a result,

control of quality cannot be realized.

With the other technique available in accordance

with the first method, namely the technique through

which all configurable network devices are configured

10   for quality control, the user can make access from any

terminal whatsoever because all of the terminals will

have been configured. However, since settings that

support all communication patterns are required for all

network devices, the storage area necessary in a network

15   device for the purpose of storing these settings is

enormous. (The size of the storage area is proportional

to the square of the number of terminals.) Since a

network device possesses only a limited storage area,

such comprehensive configuring of network devices is

20   difficult. The result is that network communication

assumed beforehand undergoes limited configuration.

With the second method, it is assumed that both

sending and receive terminals involved in communication

and all network devices (routers) on the path along

25   which this communication takes place support RSVP.

Consequently, if a network device that does not support

RSVP exists in the network, this device cannot undergo

any control of quality. If congestion occurs in regard

to this network device, even a packet in communication requiring control of quality will be discarded or delayed. The end result is that communication quality cannot be controlled. In order to avoid this problem,

5 components which support RSVP are required for all network devices and it is necessary to increase the storage area and processing capability of each network device.

SUMMARY OF THE INVENTION

10 Accordingly, an object of the present invention is to arrange it so that priority control and quality control (control of bandwidth, discard rate and delay) can be carried out even if there is a change in a terminal employed by a user or a change in network

15 configuration due to the addition of a network device.

Another object of the present invention is to arrange it so that priority control and quality control can be performed, without dependence upon a specific protocol such as RSVP, even if there is a change in a

20 terminal employed by a user or a change in network configuration due to the addition of a network device.

Another object of the present invention is to arrange it so that communication can be performed between a terminal employed by a user and a server,

25 which is the destination of communication, at a priority or quality set for the user in advance.

A further object of the present invention is to arrange it so that communication can be performed

between a user terminal that has launched an application
and a server, which is the destination of communication,
at a priority or quality set for the application in
advance.

5   (a)   First network-device control system of the
present invention

A first network-device control system according to
the present invention includes (1) an event notification
device for detecting that a user has logged in to a

10 communication terminal or that a user has launched a
predetermined application from a communication terminal,
and giving notification of an identifier of the user and
of the fact that an event has occurred, and (2) a
network-device controller for performing priority

15 control of a network device based upon information of
which notification has been given by the event
notification device. The network-device controller
acquires the priority of the user indicated by the user
identifier of which notification has been given by the

20 event notification device, obtains a network device on a
communication path between the communication terminal
employed by the user and a server which is the
destination of communication, generates information
necessary to perform priority control in accordance with

25 user priority, and sets this priority control
information in each network device (routers, etc.) on
the communication path.

In the first network-device control system

described above, the event notification device includes

(1) an event detector for detecting that a user has

logged in to a communication terminal or that a user has

launched an application from a communication terminal,

5   and (2) an event notifier for notifying the network-

device controller at least of the fact that the event

occurred and of the user identifier. Further, the

network-device controller includes (1) an event receiver

for receiving notification from the event notifier, (2)

10   a priority acquisition unit for acquiring the priority

of a user indicated by a received user identifier, (3) a

device selector for selecting a network device which is

subjected to priority control based upon the priority of

the user, (4) a device-specific information acquisition

15   unit for acquiring state of configuration of the network

device and a method of configuring the device, (5) a

configuration information generator for generating

priority-control configuration information for

performing priority control of each network device based

20   upon the acquired device-specific information and user

priority, and (6) a configuration information

transmitter for transmitting the priority-control

configuration information, which has been generated by

the configuration information generator, to the selected

25   network device to thereby set the information in this

network device.

In accordance with the first aspect of the

invention, a network device is obtained on a

communication path connecting a communication terminal employed by a user and a server that is the destination of communication, and priority control is performed upon setting priority information, which conforms to the

5   priority of the user, in this device. As a result, control of priority can be performed dynamically, without using a specific protocol such as RSVP, even if there is a change in a terminal used by a user or a change in network configuration, such as a change due to

10   the addition of a network device. Further, in accordance with the first aspect of the invention, communication between a terminal employed by a user and a server that is the destination of communication can be performed at a priority set for the user in advance. As

15   a result, by setting a priority that takes the section/department to which an employee belongs and organization into account in an enterprise network, it is possible to perform communication based upon priority control commensurate with the set priority.

20   Further, according to the first aspect of the invention, there is provided a database unit for storing, in association with a user identifier, user information that includes the address of the server that is the destination of communication and the user

25   priority. The event notification device acquires user priority and the server address from the database unit and reports these to the network-device controller. If this arrangement is adopted, the user, merely by

entering the user identifier from a communication terminal and logging in, establishes a communication path between this communication terminal and the server with which the user wishes to communicate.

5　Communication between the terminal employed by the user and the server can be performed at the priority set for the user beforehand.

Further, when an application is launched after user log-in, the priority control mentioned above can be

10　carried out. If this arrangement is adopted, the configuring of priority control necessary for the user in a network is performed more accurately by taking launching of an application by the user as an event. When priority control is necessary, such control can be

15　configured solely for the necessary network device.

(b)　Second network-device control system of the present invention

A second network-device control system according to the present invention includes (1) an event notification

20　device for detecting that a user has launched a predetermined application from a communication terminal, and giving notification of an identifier of this application and of the fact that application-launch event has occurred, and (2) a network-device controller

25　for performing priority control of a network device based upon information of which notification has been given. The network-device controller acquires the priority of the application indicated by the application

identifier of which notification has been given by the event notification device, obtains a network device on a communication path between the communication terminal and a server with which the communication terminal

5 communicates, generates information necessary to perform priority control in accordance with this priority, and configures each network device with this priority control information.

In the second network-device control system

10 described above, the event notification device includes (1) an event detector for detecting that a communication terminal has given rise to an application-launch event, and (2) an event notifier for notifying the network-device controller at least of the fact that the event

15 occurred and of the application identifier. Further, the network-device controller includes (1) an event receiver for receiving notification from the event notifier, (2) a priority acquisition unit for acquiring the priority of an application indicated by a received

20 application identifier, (3) a device selector for selecting a network device which is subjected to priority control based upon the priority of the application, (4) a device-specific information acquisition unit for acquiring state of configuration of

25 the selected network device and a method of configuring the device, (5) a configuration information generator for generating priority-control configuration information for performing priority control of each

network device based upon the acquired device-specific information and application priority, and (6) a configuration information transmitter for transmitting the priority-control configuration information, which

5 has been generated by the configuration information generator, to the selected network device to thereby set this information in this network device.

In accordance with the second aspect of the invention, a network device is obtained on a

10 communication path connecting a communication terminal employed by a user and a server that is the destination of communication, and priority control is performed upon setting priority information, which conforms to the priority of the launched application, in this device.

15 As a result, control of priority can be performed dynamically, without using a specific protocol such as RSVP, even there is a change in a terminal used by a user or a change in network configuration, such as a change due to the addition of a network device. As a

20 result, by configuring priorities for various applications in an enterprise network upon taking into account the urgency and importance of these applications, it is possible to perform communication based upon priority control commensurate with the set

25 priority.

Further, according to the second aspect of the invention, the event notification device acquires the priority of the application, the address of the server

that is the destination of communication and the address of the communicating terminal from a database unit based upon the application identifier and reports these to the network-device controller. If this arrangement is

5 adopted, the user, merely by entering the user identifier from a prescribed communication terminal, logging in and launching the prescribed application, can set up a communication path between this communication terminal and the server that conforms to the

10 application. And communication between the terminal employed by the user and the server can be performed at the priority set for the application beforehand.

(c) Third network-device control system of the present invention

15 In the first and second network-device control systems according to the present invention, priority is set in advance in conformity with the user or application and priority control is performed in accordance with the priority of the user or the priority

20 of the application.

In the third network-device control system according to the present invention, a value of bandwidth, discard rate or delay time instead of priority is configured for a user or application and

25 bandwidth control, discard-rate control or delay control is carried out in accordance with the configured value on a communication path between the terminal employed by the user and the communicating server. The

configuration of the network-device control system in accordance with the third aspect of the present invention is substantially similar to that of the first and second aspects of the invention.

5   In accordance with the third aspect of the present invention, quality control can be performed dynamically, without using a particular protocol, even if there is a change in a terminal used by a user or a change in network configuration due to the addition of a network

10   device. Further, the terminal employed by the user and the server that is the destination of communication can communicate at a quality set in advance for the user or application.

Other features and advantages of the present

15   invention will be apparent from the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram useful in describing an

20   overview of the present invention;

Fig. 2 is a diagram showing an example of the configuration of a network according to a first embodiment of the present invention;

Figs. 3A and 3B are diagrams showing an example of

25   information that has been stored in a directory server according to the first embodiment;

Figs. 4A, 4B and 4C are diagrams useful in describing the topology of network devices;

Fig. 5 is a diagram showing an example of router information that has been stored in a directory server;

Fig. 6 is a diagram useful in describing priority control;

5 Fig. 7 is a diagram useful in describing a sequence according to a first embodiment of the present invention;

Fig. 8 is a diagram showing an example of the configuration of a network according to a second

10 embodiment of the present invention;

Figs. 9A, 9B and 9C are diagrams showing an example of information that has been stored in a directory server according to the second embodiment;

Fig. 10 is a diagram useful in describing a

15 sequence according to a second example of the present invention;

Fig. 11 is a diagram showing an example of the configuration of a network according to a third embodiment of the present invention;

20 Figs. 12A, 12B and 12C are diagrams showing an example of information that has been stored in a directory server according to the third embodiment;

Fig. 13 is a diagram useful in describing a sequence according to a third example of the present

25 invention;

Fig. 14 is a diagram showing an example of the configuration of a network according to a fourth embodiment of the present invention;

Figs. 15A, 15B and 15C are diagrams showing example of information that has been stored in a directory server according to the third embodiment;

Fig. 16 is a diagram useful in describing a

5 sequence according to a fourth example of the present invention;

Fig. 17 is a diagram showing another example of information that has been stored in a directory server;

Fig. 18 is a diagram useful in describing a

10 bandwidth control sequence based upon occurrence of a log-in event;

Figs. 19A and 19B are diagrams showing an example of information that has been stored in a directory server for when bandwidth control based upon a log-in

15 event is performed; and

Fig. 20 is a diagram useful in describing RSVP control.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

(A) Overview of the present invention

20 (a) Construction

Fig. 1 is a block diagram illustrating an overview of the present invention.

In Fig. 1, an event notification device A detects and reports the fact that a user has logged in from a

25 communication terminal C or that a user has launched a predetermined application on the communication terminal C. A network-device controller B performs priority control of a network device N based upon information

reported from the event notification device A.

The event notification device A includes an event
detector A1 for detecting that a user has logged in from
the communication terminal C or that a user has launched

5   an application from a communication terminal, and an
event notifier A2 for notifying the network-device
controller B of the fact that an event occurred, the
identifier of the user or the identifier of the
application.

10   The network-device controller B includes an event
receiver B1 for receiving notification from the event
notifier A2; a configuration determination unit B2 for
acquiring the priority of a user indicated by a received
user identifier or the priority of an application

15   indicated by a received application identifier, and
determining whether it is necessary to configure for
priority control; a device selector B3 for selecting a
network device which is subjected to priority control
based upon the priority acquired; a device-specific

20   information acquisition unit B4 for acquiring the
configured state of a selected network device and a
method of configuring the device; a configuration
information generator B5 for generating priority-control
configuration information necessary for performing

25   priority control of every each network device based upon
the acquired device-specific information and priority;
and a configuration information transmitter B6 for
transmitting the priority-control configuration

information, which has been generated by the configuration information generator, to the selected network device N to thereby set this information in the network device.

5   (b)   Overview of first embodiment

The first embodiment is such that when a user logs in from a communication terminal, the network-device controller takes the log-in as an event to configure priority-control information for a network device on the

10   communication path in accordance with a priority that has been set in advance for this user, thereby performing control of priority.

In a network having a device that records in memory the fact that a user has logged in from the

15   communication terminal C, the event detector A1 reads the recorded content of the memory periodically and compares this with the previous recorded content to monitor a change in the recorded content, i.e., the occurrence of log-in. Alternatively, the event detector

20   A1 monitors the occurrence of log-in by having the above-mentioned device notify it of the fact that the stored content has been updated.

Upon detecting log-in, the event detector A1 acquires the address of the communication terminal C,

25   the identifier of the user who has logged in and the event type (log-in in this case), and the event notifier A2 reports the acquired information to the network-device controller B as event information.

In the network-device controller B, the event
receiver B1 receives the event information from the
event notification device A and delivers it to the
configuration determination unit B2. The latter

5   recognizes the fact that an event occurred at the
communication terminal C and determines, based upon the
type of event, whether configuring of priority control
is required. If the configuring is required, the
configuration determination unit B2 acquires information

10   (user priority) that has been set in advance for the
user and decides that traffic at such time that the user
utilizes the network is to be controlled in accordance
with the acquired priority. Next, the configuration
determination unit B2 notifies the device selector B3 of

15   the event information and of the fact that configuring
of priority is necessary. The device selector B3
selects, among a number of network devices (routers,
etc.) in the network, network devices on a communication
path between the communication terminal C of the user

20   and the server that is the destination of communication
obtained from information that has been set in advance
for this user. In other words, the network-device
controller B selects network devices for which control
of priority is required.

25   After the network devices have been selected, the
device selector B3 adds address information of the
devices for which the configuring of priority control is
required onto the received information from the previous

stage and delivers the resulting information to the
device-specific information acquisition unit B4. The
latter acquires, for each device indicated by the
delivered device addresses, a method of configuring

5   information for each device, configurable parameters and
states of the devices, appends this information to the
received information and delivers the resulting
information to the configuration information generator
B5. On the basis of the information received, the

10   configuration information generator B5 determines what
kind of configuration content is required for what
network device and through what method, generates, by
using the user priority, configuration content
(priority-control configuration information) for all

15   devices requiring configuring, and reports this
information to the configuration information transmitter
B6. On the basis of the priority-control configuration
information and configuration method obtained from the
configuration information generator B5, the

20   configuration information transmitter B6 transmits the
priority-control information to all network devices N on
the communication path that need to be configured,
thereby configuring these network devices.

According to the first embodiment, the event

25   notification device A detects an event and, on the basis
of the event, the network-device controller B
dynamically configures the priority-control information
for the network devices on the communication path. This

makes possible flexible control of priority that
accommodates a change in the state of a network. In
addition, it is possible to perform communication
control that conforms to the priority that has been set
5   in advance for a user. Further, the protocol between a
communication terminal (client), server and network
device can be an already existing protocol. As a
result, a network device or terminal need not be
equipped with a special protocol in order to perform
10   priority control.

(c) Overview of second embodiment

The second embodiment is such that when a user
launches an application after logging in from a
communication terminal, the network-device controller
15   takes the launching of the application as an event to
configure priority-control information for a network
device on the communication path in accordance with a
priority that has been set in advance for this user,
thereby performing priority control. Therefore, unlike
20   the first embodiment in which the configuring of
priority-control information is performed by taking log-
in as an event, the second embodiment configures
priority-control information by taking launching of an
application after log-in as the event.

25   The event detector A1 monitors the launching of
applications in a manner similar to that of the first
embodiment. Upon detecting launching of an application,
the event detector A1 acquires the address of the

communication terminal C that launched the application, the user identifier and the event type (launching of an application in this case), and the event notifier A2 reports the acquired information to the network-device

5   controller B as event information.

In the network-device controller B, the event receiver B1 receives the event information from the event notification device A and delivers it to the configuration determination unit B2. As a result, the

10   latter recognizes the fact that an event occurred at the communication terminal C and determines, based upon the type of event, whether configuring of priority control is required. If configuring is required, the configuration determination unit B2 acquires priority

15   information that has been set in advance for the user and decides that traffic at such time that the application utilizes the network is to be controlled in accordance with the priority of the user. Next, the configuration determination unit B2 notifies the device

20   selector B3 of the event information and of the fact that configuring of priority is necessary. Priority-control information is then configured for the network devices N on the communication path by control similar to that of the first embodiment.

25   According to the second embodiment, priority control is performed in accordance with a priority, which has been set in advance for the user, taking launching of an application after log-in as the event.

In comparison with the first embodiment, therefore, configuring of priority control in accordance with user priority can be performed more reliably solely for network devices necessary for communication.

5   (d) Overview of third embodiment

The third embodiment is such that when a user launches an application after logging in from a communication terminal, the network-device controller takes the launching of the application as an event to

10   configure priority-control information for a network device on the communication path in accordance with a priority that has been set in advance for this application, thereby performing priority control.

The event detector A1 monitors the launching of

15   applications in a manner similar to that of the first embodiment. Upon detecting launching of an application, the event detector A1 acquires the address of the communication terminal C that launched the application, the application identifier and the event type (launching

20   of an application in this case), and the event notifier A2 reports the acquired information to the network-device controller B as event information.

In the network-device controller B, the event receiver B1 receives the event information from the

25   event notification device A and delivers it to the configuration determination unit B2. As a result, the latter recognizes the fact that an event occurred at the communication terminal C and determines, based upon the

type of event, whether configuring of priority control
is required. If configuring is required, the
configuration determination unit B2 acquires information
(priority) that has been set in advance for the launched

5 application and decides that traffic at such time that
the application utilizes the network is to be controlled
in accordance with the above-mentioned priority. Next,
the configuration determination unit B2 notifies the
device selector B3 of the event information and of the

10 fact that configuring of priority is necessary. The
device selector B3 selects, among a number of network
devices in the network, network devices on a
communication path between the communication terminal C
of the user and the server with which the application

15 communicates. In other words, the network-device
controller B selects network devices for which control
of priority is required.

   After the network devices have been selected, the
device selector B3 adds address information of the

20 devices for which the configuring of priority control is
required onto the received information from the previous
stage and delivers the resulting information to the
device-specific information acquisition unit B4. The
latter acquires, for each device indicated by the

25 delivered device addresses, a method of configuring
information for each device, configurable parameters and
states of the devices, appends this information to the
received information and delivers the resulting

information to the configuration information generator
B5. On the basis of the information received, the
configuration information generator B5 determines what
kind of configuration content is required for what
5   network device and through what method, generates, by
using the application priority, configuration content
(priority-control configuration information) for all
devices requiring configuration, and reports this
information to the configuration information transmitter
10 B6. On the basis of the priority-control configuration
information and configuration method obtained from the
configuration information generator B5, the
configuration information transmitter B6 transmits the
priority-control information to all network devices N
15 that need to be configured, thereby configuring these
network devices.

Thus, the configuring of priority-control
information needed to execute an application can be
performed only for devices requiring priority control,
20 this being carried out taking launching of the
application by the user as the event. Further,
communication control conforming to a priority that has
been set in advance for an application can be performed.

(e)   Overview of fourth embodiment

25   The fourth embodiment is such that when a user
launches an application after logging in from a
communication terminal, the network-device controller
takes the launching of the application as an event to

configure bandwidth, which is required by the
application, for a network device on the communication
path of the application in accordance with a
communication-quality value (e.g., bandwidth) that has
5   been set in advance for this application, thereby
performing bandwidth control of this network device.

The event detector A1 monitors the launching of
applications in a manner similar to that of the first
embodiment. Upon detecting launching of an application,
10   the event detector A1 acquires the address of the
communication terminal C that launched the application,
the application identifier and the event type (launching
of an application in this case), and the event notifier
A2 reports the acquired information to the network-
15   device controller B as event information.

In the network-device controller B, the event
receiver B1 receives the event information from the
event notification device A and delivers it to the
configuration determination unit B2. The latter
20   recognizes the fact that an event occurred at the
communication terminal C and determines, based upon the
type of event, whether configuring of bandwidth is
required. If configuring is required, the configuration
determination unit B2 acquires the communication-quality
25   value (bandwidth information) of this application and
decides that communication is to be performed upon
reserving the bandwidth required by this application at
the time of communication. Next, the configuration

determination unit B2 notifies the device selector B3 of the event information and of the fact that configuring of bandwidth is necessary. The device selector B3 selects, among a number of network devices in the

5   network, network devices on a communication path between the communication terminal C of the user and the server with which this application communicates. In other words, the network-device controller B selects network devices for which configuring of bandwidth is required.

10   After the network devices have been selected, the device selector B3 adds address information of the devices for which the configuring of bandwidth is required onto the received information from the previous stage and delivers the resulting information to the

15 device-specific information acquisition unit B4. The latter acquires, for each device indicated by the delivered device addresses, a method of configuring information for each device, configurable parameters and states of the devices, appends this information to the

20 received information from the previous stage and delivers the resulting information to the configuration information generator B5. On the basis of the information received, the configuration information generator B5 determines what kind of configuration

25 content is required for what network device and through what method, generates configuration content (bandwidth-control information) for all devices for which bandwidth required by the application must be reserved, and

reports this information to the configuration information transmitter B6. On the basis of the bandwidth-control information and configuration method obtained from the configuration information generator

5 B5, the configuration information transmitter B6 transmits the bandwidth-control information to all network devices N that need to be configured, thereby configuring these network devices.

The foregoing is for a case where bandwidth

10 required by an application is configured as a communication-quality value. However, discard rate and delay time, etc., can also be configured in conformity with the application.

In accordance with the fourth embodiment, the

15 configuring of quality control such as bandwidth, discard rate and delay needed for an application can be performed in a network only for devices requiring configuring, this being carried out taking launching of the application by the user as the event.

20   (f) Overview of fifth embodiment

The fifth embodiment is such that when a user logs in from a communication terminal, the network-device controller takes log-in as an event to configure bandwidth required by a user for a network device on the

25 communication path in accordance with a communication-quality value (e.g., bandwidth) that has been set in advance for this user, thereby performing bandwidth control of this network device.

The event detector A1 monitors log-in in a manner similar to that of the first embodiment. Upon detecting log-in, the event detector A1 acquires the address of the communication terminal C, the identifier of the user

5 who logged in and the event type (log-in in this case), and the event notifier A2 reports the acquired information to the network-device controller B as event information.

In the network-device controller B, the event

10 receiver B1 receives the event information from the event notification device A and delivers it to the configuration determination unit B2. The latter recognizes the fact that an event occurred at the communication terminal C and determines, based upon the

15 type of event, whether configuring of bandwidth is required. If configuring is required, the configuration determination unit B2 refers to the communication-quality value (bandwidth information) that has been set in advance for this user and decides that communication

20 is to be performed upon reserving the bandwidth required at the time of communication. Next, the configuration determination unit B2 notifies the device selector B3 of the event information and of the fact that configuring of bandwidth is necessary. The device selector B3

25 selects, among a number of network devices in the network, network devices on a communication path between the communication terminal C of the user and the communication-destination server obtained from

information that has been set in advance for this user.
In other words, the network-device controller B selects
network devices for which configuring of bandwidth is
required.

5   After the network devices have been selected, the
device selector B3 adds address information of the
devices for which the configuring of bandwidth is
required onto the received information from the previous
stage and delivers the resulting information to the

10 device-specific information acquisition unit B4. The
latter acquires, for each device indicated by the
delivered device addresses, a method of configuring
information for each device, configurable parameters and
states of the devices, appends this information to the

15 received information from the previous stage and
delivers the resulting information to the configuration
information generator B5. On the basis of the
information received, the configuration information
generator B5 determines what kind of configuration

20 content is required for what network device and through
what method, generates configuration content (bandwidth-
control information) for all devices for which bandwidth
required by the user must be reserved, and reports this
information to the configuration information transmitter

25 B6. On the basis of the bandwidth-control information
and configuration method obtained from the configuration
information generator B5, the configuration information
transmitter B6 transmits the bandwidth-control

information to all network devices N that need to be configured, thereby configuring these network devices.

The foregoing is for a case where bandwidth required by an user is configured as a communication-quality value. However, discard rate and delay time, etc., can also be configured in conformity with the user.

In accordance with the fifth embodiment, the configuring of quality control such as bandwidth, discard rate and delay needed for a user can be performed in a network only for devices requiring configuring, this being carried out taking user log-in as the event.

(B) First embodiment

(a) Configuration

Fig. 2 is a diagram showing an example of the configuration of a network according to a first embodiment of the present invention. Shown in Fig. 2 are a client 11 (end terminal) such as a personal computer; a server 12 having a function for storing data for a prescribed application, such as management application data and personnel application data, and distributing the data to clients; networks 13_1 to 13_3; routers 14_1, 14_2 for connecting these networks; switches (exchanges) 15_1 to 15_4 provided in the networks; a directory server 16 having a database for storing user information on a per-user (e.g., employee) basis; an event notifier 17 for detecting a log-in event and

reporting event information; and a configuration server 18 which uses log-in as an event to configure the priority, which has been set for the user, for the network devices 15_1, 14_1, 15_3, 14_2, 15_4 on a

5   communication path CPT.

Fig. 2 illustrates an example of a network configuration for when the client 11 accesses the server 12. This assumes a situation where the client 11 accesses the server 12 via a network composed of various

10   routers and switches and either receives information that has been stored in the server 12 from the server 12 or transmits information to the server 12 to store the data in the server 12. In order to avoid a delay in receiving time or transmitting time and the discarding

15   of information owing to the effects of other traffic within the network at the time of such communication, each router traversed by desired traffic provides a service through which packets are transported at a priority higher than that of other traffic. A method of

20   applying the present invention in such case will be described below.

(b)   Functions of components

The network according to the first embodiment is composed of the client 11, the server 12, the directory

25   server 16, the event notifier 17 and the configuration server 18. The directory server 16, a Lightweight Directory Access Protocol (LDAP) for accessing this directory server, and the function through which the

client 11 gives notification of log-in by LDAP

constitute prior art.

(b-1) Client

The client 11 in this embodiment is an end terminal

5   such as a personal computer. The client 11 is connected

to the network. If a user logs in this client, user

information (the user identifier) is reported to the

directory server 16 using LDAP. More specifically, when

the user logs in by entering a user identifier or

10 password, etc., from the client 11, the latter reports

the user identifier and its own IP address to the

directory server 16 by LDAP.

(b-2) Directory server

The directory server 16 manages, in the form of a

15 database, information relating to users who log in from

each client. As shown in Fig. 3A, the directory server

16 retains, in a form corresponding to each user

identifier, (1) the IP address of an important server

accessed in dedicated fashion by the user, (2) priority

20 when the user utilizes the network, and (3) other user-

specific information. For example, if the network is

one constructed within an enterprise, the following will

be stored in the database of the directory server 16 in

correspondence with user identification of each employee

25 (i.e., employee number): (1) the IP address of an

important server accessed in dedicated fashion by the

employee for business-related reasons, (2) priority when

the employee utilizes the network, (3) other specific

information. Important servers accessed in dedicated

fashion by an employee for business-related reasons

correspond in one-to-one fashion to the section to which

the employee belongs (accounting department, personnel

5   department, planning department, patent department,

technical department, etc.). Priority for utilizing a

server is decided in dependence upon organization

(person in charge, manager, section chief, department

chief, etc.). Accordingly, the address of the important

10   server and the priority are set in advance taking the

post of the employee and the organization into account,

and these are registered in the database.

The client 11 accesses the directory server 16

using LDAP. More specifically, the client executes

15   database processing in regard to the user information

using LDAP (the processing including responding to

inquiries, updating information and creating of

information). When a user logs in by inputting the user

identifier from the client 11, the latter reports the

20   user identifier and the IP address of the client to the

directory server 16. Upon receiving the identifier and

IP address, the directory server 16 registers the IP

address of the client in the database in correspondence

with the above-mentioned user identifier, as shown in

25   Fig. 3B.

For example, as shown in Fig. 3A, (1) 192.168.20.30

(= IPs) has been registered beforehand in the database

of the directory server 16 and (2) 8 has been registered

as the priority in the database of directory server 16
in correspondence with a user identifier "fujitsu". If
user A logs in by inputting the user identifier
"fujitsu" from the client 11 under these conditions, the
5   IP address 192.168.10.20 (IPc) of the client 11 is
registered in the database anew as the user-specific
information of user A, as shown in Fig. 3B.

    (b-3)   Event notifier

    The event notifier 17 has a function for notifying
10   the configuration server 18 of any change that has
occurred on the network and of the status of the
network. Though the event notifier 17 is shown as being
separate from the directory server 16 in Fig. 2, it is
actually provided within the directory server 16. The
15   event notifier 17 monitors a change in a prescribed item
of each user in the database of the directory server 16
from a logged-off state (a state in which there is no
record of a logged-in client) to a logged-in state (a
state in which there is a record of a logged-in client)
20   and, if a change has occurred, notifies the
configuration server 18 of (1) the user identifier for
which the change has occurred, (2) the IP address of the
client who has logged in, and (3) the fact that an event
has occurred due to log-in (i.e., the type of event).

25   The monitoring of a change in prescribed items in
the database can be implemented by having the event
notifier 17 read out the database information of the
directory server 16 periodically and compare the

information with that read out previously.

(b-4)   Configuration server

The configuration server 18 has the following functions (1) to (4):

5   (1)   Upon receiving notification of the user log-in event from the event notifier 17, the configuration server 18 uses the user identifier as a key to query the directory server 16 as to the IP address of the important server utilized by the user and the priority

10   of the user and obtains responses regarding the IP address and user priority.

(2)   Next, using IP routing information from the IP address of the client 11 and the IP address of the server 12, the configuration server 18 specifies the

15   routers 14_1, 14_2 and the switches 15_1, 15_3, 15_4 that relay the sent and received traffic that occurs between the client 11 and the server 12. More specifically, the configuration server 18 identifies the network devices on the communication path CPT between the client 11 and

20   server 12. This identification processing performed by the relaying routers is executed as follows: If the network is one which uses OSPF (Open Shortest Path First) as the IP routing protocol, the configuration server 18 receives an OSPF LSA (Link State

25   Advertisement) packet that has been broadcast within the network. The LSA packet contains topology information indicating the router connection relationship. When the LSA packet is received, therefore, the router topology

can be ascertained. On the basis of this topology
information, the shortest path is calculated from the
known IP addresses of the client 11 and server 12 using
the Dijkstra algorithm and, hence, the IP routing

5 information is obtained. The configuration server 18 is
capable of obtaining the path between the client and
server through this procedure. That is, the
configuration server 18 is capable of identifying the
relaying routers.

10   Figs. 4A to 4C are diagrams useful in describing
the router topology information. In a case where
routers A to E are connected as shown in Fig. 4C, the
topology information of router A is a list of IP
addresses of the adjacent routers, as shown in Fig. 4A,

15 and the topology information of router B is a list of IP
addresses of the adjacent routers, as shown in Fig. 4B.
In other words, Fig. 4A expresses the fact that router A
having the IP address 192.168.15.1 has been connected to
the three routers B, C and D. In regard to router B

20 having the IP address 192.168.10.1 among these three
routers, it is indicated that there are two adjacent
routers, namely routers A and E, as shown in Fig. 4B.
Thus, a list of other routers to which a certain router
is connected is expressed as one table and these tables

25 are prepared in a number equivalent to the number of
nodes, thereby expressing the topology of the network.

      (3) The configuration server 18 acquires
information relating to each router (the states of the

routers and configuration items) from the obtained IP
addresses of the relaying routers. The states and
configuration items are, e.g., configurable parameters,
parameters that have already been configured, protocols
5   utilized in configuring and the methods of
configuration.

   These items of information may be applied to the
configuration server 18 in advance, or each router may
be inquired about them using a protocol such as SNMP
10   (Simple Network Management Protocol), or they may be
registered together with user information as one item of
network-device information (router information) and
obtained by querying the directory server 16 using LDAP
with the IP address of the router serving as a key. For
15   example, the fact that logging in to a router is
performed by Telnet, the fact that a determined ID and
password are necessary, and the fact that it is possible
to make various settings and obtain information by
execution of commands are stipulated by the router
20   information.

   Fig. 5 illustrates an example of a case where
router information has been stored in the directory
server 16. The attributes of the router A are stored in
the form of a sub-tree of a tree structure. The
25   attributes are the IP address of the router, the queue
control scheme (the name "priority" is entered here and
signifies a priority control scheme), the number (two)
of queues, the configuration protocol (Telnet in this

example) and the names (Queue 1, Queue 2) assigned to
the respective queues. This illustrates a case in which
priorities 1, 2 have been entered for the queues.

Fig. 6 is a diagram useful in describing a priority
5 control scheme for a router. The scheme includes the
queue 1 of priority 1 (the highest priority), the queue
2 of priority 2 (the lowest priority), an allocation
unit 3 for allocating input packets to the queues 1, 2,
and a readout controller 4 for reading packets out of
10 the queue 1 of highest priority in the order of arrival,
outputting the packets to a line and, only when no
packets are present in the queue of highest priority,
for reading packets out of the queue 2 of lowest
priority in the order of arrival and outputting the
15 packets to the line. In order to subject a prescribed
packet to high-priority processing, the fact that the
packet is to be processed at the high priority is set in
the allocation unit 3 together with the packet
identification data. In response, from among the
20 arriving packets, the allocation unit 3 inputs the
packet having the above-mentioned identification data to
the high-priority queue 1 so that the packet is
subjected to high-priority processing.

(4) On the basis of the priority of the user, the
25 configuration server 18 obtains a priority control
parameter to configure the network device. For example,
if the user priority entered from the directory server
16 is 8 and a router can be set to only two, namely high

and low, priorities, the configuration server 18
determines whether the user priority of 8 is the high or
low priority and, if it is the high priority, configures
the router to the high priority.

5   By repeating the above configuring for each router,
the configuring of the priority of all routers on the
communication path from the client 11 to the server 12
will eventually be completed and, as a result, it will
be possible to provide a service for communicating
10   traffic between the client and server at a priority
higher than that of other traffic.

(c)   Priority configuration sequence

Fig. 7 is a diagram useful in describing a priority
configuration sequence according to the first
15   embodiment.   This illustrates a case in which when the
user has logged in from the client 11, the configuration
server 18 uses log-in as an event to perform control of
priority by configuring the routers 14_1, 14_2 on the
communication path with priority control information in
20   accordance with a priority set in advance for this user.

I.   When the user having the user identifier
"fujitsu" logs in to the communication terminal (client)
11 having the IP address 192.169.10.20 (= IPc), the
client 11 sends the directory server 16 an LDAP message
25   for updating the information concerning the user
identifier "fujitsu".   The LDAP message contains the
user identifier "fujitsu" and the IP address of the
client.   The directory server 16 registers the IP

address of the client in association with the user
identifier "fujitsu" in the database (see Fig. 3B).

II.   The event notifier 17 within the directory
server 16 detects log-in and notifies the configuration
5   server 18 of the fact that a user having the user
identifier "fujitsu" has logged in to the client 11
having the IP address IPc.

III.   The configuration server 18 queries the
directory server in regard to the priority of the user
10   by LDAP using the user identifier "fujitsu" as the key
and obtains, as a response, the fact that the address of
the server 12 is 192.168.20.30 (= IPs) and that the
priority is 8.

IV.   Next, on the basis of OSPF information, the
15   configuration server 18 finds a router that relays the
communication between the client 11 and the server 12.
Assume that the IP address of the one router 14_1 is
"192.168.15.1 (= IPr)".

V.   The configuration server 18 obtains the state
20   of the router 14_1 and information (Fig. 5) relating to
the configuration items.   As a result, the router 14_1
can be configured using Telnet and it is ascertained
that this router possesses two priority settings, namely
high and low.

25   VI.   If the priority that has been assigned to the
user identifier "fujitsu" has a value of 8 (the maximum
value being 10) among ten priority levels, the
configuration server 18 recognizes that the router 14_1

is to be configured for high-priority processing. Next,

the configuration server 18 performs Telnet

communication for the router 14_1 of IP address IPr and

establishes a high priority for communication for which

5   the IP address on the originating side is IPc and the IP

address at the destination is IPs.

VII. The configuring of priority processing

described above is performed for other routers as well.

(d)   Modification

10   In the embodiment set forth above, a router on the

communication path between the client and server is

found using OSPF. However, the topology and IP

communication path may be found based upon other routing

protocol information such as RIP (Routing Information

15   Protocol) and a network management protocol such as SNMP

may be used. Further, the client 11 may execute

traceroute processing with regard to a destination IP

address, thereby finding the IP address of a router on

the communication path so that this information may be

20   acquired by the configuration server 18. With this

method, the configuration server need not compute

topology information and path.

According to the above-described embodiment, user

information has been stored in the directory server.

25   However, the state of log-in can be managed also by

using another database having a data management

function.

With the foregoing embodiment, LDAP is utilized for

the delivery of user data. However, any protocol can be utilized as long as it is capable of acquiring data.

In the foregoing embodiment, the case assumed is one in which the priority of the user or the IP address of an important server is obtained. In a case where these are not obtained, however, configuring need not be performed or a priority or IP address given beforehand may be set instead of these values.

Further, according to the foregoing embodiment, only one important server exists. However, in a case where there are a plurality of servers, the above-described embodiment can be applied to each one.

Further, according to the foregoing embodiment, configuring of priority is attempted for all relaying routers. However, the configuring of priority may be performed for a router decided in advance. The configuring of priority may be performed even for switches of a MAC (Media Access Control) layer in addition to relaying routers present on the communication path.

Further, according to the foregoing embodiment, the configuring of priority is carried out when an event occurs. However, the configuration server may periodically check for a change in path information or user information and, when such a change is detected, may cancel the original settings and then perform a reconfiguring operation, thereby making possible control of priority for dealing with a change in network

configuration or user information after settings have been made. Alternatively, the event detector may detect a change in user information and network configuration and notify the configuration server, in response to

5   which the configuration server may cancel the original setting and then perform a reconfiguring operation. Further, the monitoring of a change in a prescribed item in the database can be implemented by adding on an event detector as part of the function for writing data from

10 the directory server 16 to the database.

The modification set forth above can be applied to embodiments described below as well.

(C)   Second embodiment

(a)   Construction

15 Fig. 8 is a diagram illustrating an example of the construction of a second embodiment of the present invention. Components identical with those of the first embodiment shown in Fig. 2 are designated by like reference characters.

20 According to the second embodiment, the event notifier 17 performs monitoring to determine that the user has launched an application at an end terminal and the configuration server 18 performs configuration for control of priority based upon detection of launching of

25 the application (detection of an event). More specifically, the second embodiment differs from the first embodiment in terms of the monitoring function of the event notifier 17. Performing control of priority

at launching of an application following log-in, as is

done in the second embodiment, is better than performing

control of priority at the time of log-in, as is done in

the first embodiment, for the purpose of configuring the

5   priority of a router in strict conformity with the case

in which traffic is actually utilized.

As in the first embodiment, the network of this

embodiment includes the client 11, the server 12, the

directory server 16, the event notifier 17 and the

10   configuration server 18.

(b)   Functions of components

(b-1)   Client

The client 11 is an end terminal such as a personal

computer and is connected to the network. If a user

15   logs in utilizing the client 11, user information (the

user identifier) is reported to the directory server 16

using LDAP. More specifically, when the user logs in by

entering a user identifier or password, etc., from the

client 11, the latter reports the user identifier and

20   its own IP address to the directory server 16 by LDAP.

Similarly, if a certain user launches a prescribed

application using the client 11, the latter registers

the application information (the application identifier

and the IP address of the server with which this

25   application communicates) in the directory server 16

using LDAP.

(b-2)   Directory server

The directory server 16 manages, in the form of a

database, information relating to users and information relating to applications launched by users. More specifically, the directory server 16 retains, in the form of a database, (1) a user identifier, (2) the IP

5   address of an end terminal at which the user has logged in, (3) the identifier of an application utilized by the user, (4) the IP address of the server with which this application communicates, and (5) the priority for when the user utilizes the network (see Fig. 9C). The client

10   11, which is an end terminal, accesses the directory server 16 using LDAP and subjects the user information to database processing (processing such as responding to inquiries, updating information and creating information). When a user has logged in or launched an

15   application, the client 11 notifies the directory server 16 of the information relating to the user or of the information relating to the application.

As shown in Fig. 9A, (1) the priority for when the user utilizes the network and (2) other user-specific

20   information have initially been registered in the database of directory server 16 in correspondence with a user identifier. If the user logs in by inputting the user identifier from the client 11 under these conditions, the client 11 notifies the directory server

25   16 of the user identifier and IP address of the client by LDAP. Upon receiving the identifier and IP address, the directory server 16 registers the IP address of the client in the database in correspondence with the above-

mentioned user identifier, as shown in Fig. 9B. For

example, as shown in Fig. 9A, 8 has been registered as

the priority in the database of directory server 16 in

correspondence with the user identifier "fujitsu". If

5   user A logs in by inputting the user identifier

"fujitsu" from the client 11 under these conditions, the

IP address 192.168.10.20 (= IPc) of the client 11 is

registered in the database anew as the user-specific

information of user A, as shown in Fig. 9B.

10   Similarly, if the user launches an application that

utilizes an accounts database, the client 11 notifies

the directory server 16 of the identifier "accounting"

of the above-mentioned application and of the IP address

"192.168.30.11 (= IPa)" of the accounts server 12, which

15   is the destination with which this application

communicates, by LDAP. Upon being so notified, the

directory server 16 registers the application identifier

"accounting" and the IP address 192.168.30.11 (= IPa) in

the database, as shown in Fig. 9C.

20   (b-3)   Event notifier

     The event notifier 17 has a function for notifying

the configuration server 18 of any change that has

occurred on the network and of the status of the

network. Though the event notifier 17 is shown as being

25   separate from the directory server 16, it is actually

provided within the directory server 16. The event

notifier 17 monitors, on a per-user basis, a change in

state from an application-inactive state (a state in

which an application identifier has not been registered
in the directory server) to an application-launched
state (a state in which an application identifier has
been registered in the directory server) and, if a

5   change has occurred, notifies the configuration server
18 of (1) the IP address IPc of the end terminal that
launched the application, (2) the identifier of the
launched application, (3) the IP address IPa of the
destination with which the application communicates, and

10   (4) the fact that an application-launch event has
occurred (i.e., the type of event).

The monitoring of a change in application
information in the database can be implemented by having
the event notifier 17 read out the database information

15   of the directory server 16 periodically and compare the
information with that read out previously.

(b-4)   Configuration server

The configuration server 18 has the following
functions (1) to (4):

20   (1)   Upon receiving notification of the
application-launch event from the event notifier 17, the
configuration server 18 uses the IP address of the end
terminal that launched this application as a key to
query the directory server 16 as to the priority of the

25   user who is utilizing the end terminal and obtains a
response regarding this inquiry. In this embodiment, a
response to the effect that the priority is 8 is
obtained when the directory server 16 is queried using

the IP address IPc as the key.

It should be noted that an arrangement can be adopted in which the configuration server 18 has the event notifier 17 report the user identifier in addition

5   to the application information, uses this user identifier to query the directory server 16 with regard to the priority of the user who is utilizing the end terminal and acquires this priority.

(2)   Next, through a method similar to that of the

10 first embodiment, the configuration server 18 uses the reported IP addresses of the client 11 and server 12 and the IP routing information to specify the routers 14_1, 14_2 and the switches 15_1, 15_3, 15_4 that relay the sent and received traffic that occurs between the client 11

15 and the server 12.   More specifically, the configuration server 18 identifies the network devices on the communication path CPT between the client 11 and server 12.

(3)   The configuration server 18 acquires

20 information relating to each router (the states of the routers and the configuration items) from the obtained IP addresses of the relaying routers 14_1, 14_2.

(4)   On the basis of the router information and priority of the user, the configuration server 18

25 generates a priority control parameter to configure the router and sets this parameter in the router.   For example, if the user priority entered from the directory server 16 is 8 and a router can be set to only two,

namely high and low, priorities, the configuration server 18 determines whether the user priority of 8 is the high or low priority and, if it is the high priority, sets the router to the high priority.

5   By repeating the above configuring for each router, the configuring of the priority of all routers on the communication path from the client 11 to the server 12 will eventually be completed and, as a result, it will be possible to provide a service for communicating

10   traffic between the client and server at a priority higher than that of other traffic.

       (c)   Priority configuration sequence

       Fig. 10 is a diagram useful in describing a priority configuration sequence according to the first

15   embodiment. This illustrates a case in which when the user has logged in from the client 11 and then launched an application, the configuration server 18 uses launching of the application as an event to perform priority control by configuring the routers 14_1, 14_2 on

20   the communication path with priority control information in accordance with a priority set in advance for this user.

       I.   When the user having the user identifier "fujitsu" logs in to the communication terminal (client)

25   11 having the IP address 192.169.10.20 (= IPc), the client 11 sends the directory server 16 an LDAP message for updating the information concerning the user identifier "fujitsu". Accordingly, the LDAP message

contains the user identifier "fujitsu" and the IP

address of the client. The directory server 16

registers the IP address of the client in association

with the user identifier "fujitsu" in the database (see

5 Fig. 9B).

II. When the user having the user identifier

"fujitsu" launches a prescribed application at the

client 11 having the IP address IPc, this client sends

the directory server 16 an LDAP message in order to

10 register the application information in the directory

server 16. The LDAP message contains, as application

information, (1) the application identifier "accounting"

launched by the user having the user identifier

"fujitsu", and (2) the IP address 192.168.30.11 (= IPa)

15 of the server with which the application communicates.

Accordingly, the directory server 16 registers the

application identifier "accounting" and the IP address

192.168.30.11 (= IPa) of the server with which this

application communicates in the database in association

20 with the user identifier "fujitsu" (see Fig. 9C).

III. If the event notifier 17 within the directory

server 16 detects launching of the application, the

event notifier 17 notifies the configuration server 18

of the fact that an application which has the

25 application identifier "accounting" and which

communicates with a server having the IP address IPa has

been launched at the client 11 having the IP address

IPc.

IV.   The configuration server 18 queries the
directory server 16 in regard to the priority of the
user by LDAP using the IP address (= IPc) of the
communication terminal as the key and obtains, as a
5   response, the fact that the priority is 8.

V.   Next, on the basis of OSPF information, the
configuration server 18 finds a router that relays the
communication between the client 11 and the server 12.
Assume that the IP address of the one router 14_1 is
10   "192.168.15.1 (= IPr)".

VI.   The configuration server 18 obtains the state
of the router 14_1 and information (Fig. 5) relating to
the configuration items.   As a result, the router 14_1
can be configured using Telnet and it is ascertained
15   that this router possesses two priority settings, namely
high and low.

VII.   If the priority that has been assigned to the
user identifier "fujitsu" has a value of 8 (the maximum
value being 10) among ten priority levels, the
20   configuration server 18 recognizes that the router 14_1
is to be configured for high-priority processing.   Next,
the configuration server 18 performs Telnet
communication for the router 14_1 of IP address IPr and
establishes a high priority for communication for which
25   the IP address on the originating side is IPc and the IP
address at the destination is IPs.

VIII.   The configuring of priority processing
described above is performed for other routers as well.

(D)   Third embodiment

(a)   Construction

Fig. 11 is a diagram illustrating an example of the construction of a third embodiment of the present invention.   Components identical with those of the second embodiment shown in Fig. 8 are designated by like reference characters.

According to the third embodiment, the event notifier 17 performs monitoring to determine that an application has been launched at an end terminal and, on the basis of detection of application launch (event detection), the configuration server 18 configures priority for a router on the communication path of the application.   In the second embodiment, configuring of priority is performed for a router by utilizing a priority that is decided for each user.   In the third embodiment, however, configuring of priority is performed for a router by utilizing a priority that is decided for each application.   In accordance with the third embodiment, priority control made to conform to the characteristics of the application becomes possible.

As in the first and second embodiments, the network according to the third embodiment includes the client 11, the server 12, the directory server 16, the event notifier 17 and the configuration server 18.

(b)   Functions of components

(b-1)   Client

The client 11 is an end terminal such as a personal

computer and is connected to the network. If a user

logs in utilizing the client 11, user information (the

user identifier) is registered in the directory server

16 using LDAP. More specifically, when the user logs in

5   by entering a user identifier or password, etc., from

the client 11, the latter registers the user identifier

and its own IP address in the directory server 16 by

LDAP. Similarly, if a certain user launches a

prescribed application using the client 11, the latter

10   registers the application information (the application

identifier and the IP address of the server with which

the application communicates) in the directory server 16

using LDAP.

It should be noted that if application priority and

15   the IP address of the communication-destination server

of the application have been registered in the directory

server 16 in association with the application

identifier, the client need only register the

application identifier in the directory server 16 as the

20   application information.

(b-2)   Directory server

The directory server 16 manages, in the form of a

database, information relating to users and information

relating to applications launched by users. The user

25   information contains (1) the user identifier, (2) the IP

address of the end terminal at which the user has logged

in, (3) the identifier of the application utilized by

the user, (4) the IP address of the server with which

this application communicates, and (5) other specific information (see Fig. 11C). Further, the application information contains (1) the application identifier and (2) the priority of the application. However, the

5 application information can include the IP address of the server with which the application communicates.

The client 11, which is an end terminal, accesses the directory server 16 using LDAP and subjects the user information to database processing (processing such as

10 responding to inquiries, updating information and creating information). When a user has logged in or launched an application, the client 11 notifies the directory server 16 of the information relating to the user or of the information relating to the application.

15 As shown in Fig. 12A, only user-specific information has initially been registered in the directory server 16 in correspondence with a user identifier. An application priority of 6 has been registered in correspondence with the application

20 identifier "accounting".

If the user logs in by inputting the user identifier from the client 11 under these conditions, the client 11 notifies the directory server 16 of the user identifier and IP address of the client by LDAP.

25 Upon receiving the identifier and IP address, the directory server 16 registers the IP address 192.168.10.20 (= IPc) of the client in correspondence with the above-mentioned user identifier, as shown in

Fig. 12B.

Similarly, if the user launches an application that utilizes an accounts database, for example, the client 11 notifies the directory server 16 of the identifier

5   "accounting" of the above-mentioned application and of the IP address "192.168.30.11 (= IPa)" of the accounts server 12, which is the destination with which this application communicates, by LDAP. Upon being so notified, the directory server 16 registers the

10   application identifier and the IP address of the server, which is the destination with which the application communicates, in the database, as shown in Fig. 12C.

(b-3)   Event notifier

The event notifier 17 has a function for notifying

15   the configuration server 18 of any change that has occurred on the network and of the status of the network. Though the event notifier 17 is shown as being separate from the directory server 16, it is actually provided within the directory server 16. The event

20   notifier 17 monitors, on a per-user basis, a change in state from an application-inactive state to an application-launched state and, if a change has occurred, notifies the configuration server 18 of (1) the IP address IPc of the end terminal that launched the

25   application, (2) the identifier of the launched application, (3) the IP address IPa of the destination with which the application communicates, and (4) the fact that an application-launch event has occurred

(i.e., the type of event).

The monitoring of a change in application information in the database can be implemented by having the event notifier 17 read out the database information
5   of the directory server 16 periodically and compare the information with that read out previously.

(b-4)   Configuration server

The configuration server 18 has the following functions (1) to (4):
10   (1)   Upon receiving notification of the application-launch event from the event notifier 17, the configuration server 18 uses the application identifier contained in the event notification as a key to query the directory server 16 as to the priority, on the
15   network, of the application that has been launched at the end terminal, and obtains a response regarding this inquiry.   In this embodiment, a response to the effect that the priority is 6 is obtained when the directory server 16 is queried using the application identifier
20   "accounting" as the key.

(2)   Next, through a method similar to that of the first embodiment, the configuration server 18 uses the reported IP addresses of the client 11 and server 12 and the IP routing information to specify the routers 14_1,
25   14_2 and the switches 15_1, 15_3, 15_4 that relay the sent and received traffic that occurs between the client 11 and the server 12.   More specifically, the configuration server 18 identifies the network devices (routers and

switches) on the communication path CPT between the client 11 and server 12.

(3) The configuration server 18 acquires information relating to each router (the states of the routers and the configuration items) from the obtained IP addresses of the relaying routers.

(4) On the basis of the router information and priority of the application, the configuration server 18 generates a priority control parameter to configure the router and, using a setting protocol, sets this parameter in the router that relays the communication between the client and the server. By repeating the above configuring for each router, the configuring of the priority of all routers on the communication path from the client 11 to the server 12 will eventually be completed and, as a result, it will be possible to provide a service for communicating traffic between the client and server at a priority higher than that of other traffic.

(c) Priority configuration sequence

Fig. 13 is a diagram useful in describing a priority configuration sequence according to the third embodiment. This illustrates a case in which when the user has logged in from the client 11 and then launched an application, the configuration server 18 uses launching of the application as an event to perform priority control by configuring priority control information for the routers 14_1, 14_2 on the

communication path in accordance with a priority set in
advance for this application.

I.   When the user having the user identifier
"fujitsu" logs in to the communication terminal (client)

5   11 having the IP address 192.169.10.20 (= IPc), the
client 11 sends the directory server 16 an LDAP message
for updating the information concerning the user
identifier "fujitsu". The LDAP message contains the
user identifier "fujitsu" and the IP address of the

10   client. Accordingly, the directory server 16 registers
the IP address of the client in association with the
user identifier "fujitsu" in the database (see Fig.
11B).

II.   When the user having the user identifier

15   "fujitsu" launches a prescribed application at the
client 11 having the IP address IPc, this client sends
the directory server 16 an LDAP message in order to
register the application information. The LDAP message
contains, as application information, the application

20   identifier "accounting" launched by the user having the
user identifier "fujitsu", and the IP address
192.168.30.11 (= IPa) of the server with which the
application communicates. Accordingly, the directory
server 16 registers the application identifier

25   "accounting" and the IP address 192.168.30.11 (= IPa) of
the server with which this application communicates in
the database in association with the user identifier
"fujitsu" (see Fig. 12C).

III. If the event notifier 17 within the directory server 16 detects launching of the application, the event notifier 17 notifies the configuration server 18 of the fact that an application which has the

5 application identifier "accounting" and which communicates with a server having the IP address IPa has been launched at the client 11 having the IP address IPc.

IV. The configuration server 18 queries the

10 directory server 16 in regard to the priority of the application by LDAP using the application identifier "accounting" as the key and obtains, as a response, the fact that the priority is 6.

V. Next, on the basis of OSPF information, the

15 configuration server 18 finds a router that relays the communication between the client 11 and the server 12. Assume that the IP address of the one router 14_1 is "192.168.15.1 (= IPr)".

VI. The configuration server 18 obtains the state

20 of the router 14_1 and information relating to the configuration items. As a result, the router 14_1 can be configured using Telnet and the configuration server 18 can ascertain that this router possesses two priority settings, namely high and low.

25 VII. If the priority that has been assigned to the application has a value of 6 (the maximum value being 10) among ten priority levels, the configuration server 18 recognizes that the router IPr is to be configured

for high-priority processing. Next, the configuration server 18 performs Telnet communication for the router 14_1 of IP address IPr and establishes a high priority for communication for which the IP address on the

5 originating side is IPc and the IP address at the destination is IPa.

VIII. The configuring of priority processing described above is performed for other routers as well.

(E) Fourth embodiment

10 (a) Construction

Fig. 14 is a diagram illustrating an example of the construction of a fourth embodiment of the present invention. Components identical with those of the third embodiment shown in Fig. 11 are designated by like

15 reference characters. In the third embodiment, priority configuration for a router on the communication path of an application is performed based upon the priority of the application. In the fourth embodiment, however, bandwidth is configured for a router on the

20 communication path of an application based upon the bandwidth required by the application. In accordance with the fourth embodiment, it is possible to assure communication quality more reliably in comparison with priority control.

25 As in the first through third embodiments, the network according to the fourth embodiment includes the client 11, the server 12, the directory server 16, the event notifier 17 and the configuration server 18.

(b)   Functions of components

(b-1)   Client

The client 11 is an end terminal such as a personal

computer and is connected to the network.   If a user

5   logs in utilizing the client 11, user information (the

user identifier) is registered in the directory server

16 using LDAP.   More specifically, when the user logs in

by entering a user identifier or password, etc., from

the client 11, the latter registers the user identifier

10   and its own IP address in the directory server 16 by

LDAP.   Similarly, if a certain user launches a

prescribed application using the client 11, the latter

registers the application information (the application

identifier and the IP address of the communication-

15   destination server of the application) in the directory

server 16 using LDAP.   Similarly, if a certain user

launches a prescribed application using the client 11,

the latter registers the application information (the

application identifier and the IP address of the server

20   with which the application communicates) in the

directory server 16 using LDAP.

(b-2)   Directory server

The directory server 16 manages, in the form of a

database, information relating to users and information

25   relating to applications launched by users.   The user

information contains (1) the user identifier, (2) the IP

address of the end terminal at which the user has logged

in, (3) the identifier of the application utilized by

the user, (4) the IP address of the server with which
this application communicates, and (5) other specific
information (see Fig. 15C). Further, the application
information contains (1) the application identifier and
5   (2) the bandwidth required by the application. The
application information can include the IP address of
the server with which the application communicates.

The client 11, which is an end terminal, accesses
the directory server 16 using LDAP and subjects the user
10   information to database processing (processing such as
responding to inquiries, updating information and
creation of information). When a user has logged in or
launched an application, the client 11 notifies the
directory server 16 of the information relating to the
15   user or of the information relating to the application.

As shown in Fig. 15A, only user-specific
information has initially been registered in the
directory server 16 in correspondence with a user
identifier. A bandwidth of 1.5 Mbps required by the
20   application has been registered in correspondence with
the application identifier "videoplayer". If the user
logs in by inputting the user identifier "fujitsu" from
the client 11 under these conditions, the client 11
notifies the directory server 16 of the user identifier
25   and IP address 192.168.10.20 (= IPc) of the client by
LDAP. Upon receiving the user identifier and IP
address, the directory server 16 registers the IP
address IPc of the client in correspondence with the

above-mentioned user identifier, as shown in Fig. 15B.

Similarly, if the user launches an application for reproducing video, the client 11 notifies the directory server 16 of the identifier "videoplayer" of the above-

5 mentioned application and of the IP address "192.168.30.11 (= IPa)" of the video server 12, which is the destination with which this application communicates, by LDAP. Upon being so notified, the directory server 16 registers the application identifier

10 "videoplayer" and the IP address (= IPa) of the video server, which is the destination with which the application communicates, in the user information field of the database, as shown in Fig. 15C.

(b-3) Event notifier

15 The event notifier 17 has a function for notifying the configuration server 18 of any change that has occurred on the network and of the status of the network. Though the event notifier 17 is shown as being separate from the directory server 16, it is actually

20 provided within the directory server 16. The event notifier 17 monitors, on a per-user basis, a change in state from an application-inactive state to an application-launched state and, if a change has occurred, notifies the configuration server 18 of (1)

25 the IP address IPc of the end terminal that launched the application, (2) the identifier of the launched application, (3) the IP address IPa of the destination with which the application communicates, and (4) an

event notifier "application", which indicates the fact that an application-launch event has occurred.

The monitoring of a change in application information in the database can be implemented by having
5   the event notifier 17 read out the database information of the directory server 16 periodically and compare the information with that read out previously.

(b-4)   Configuration server

The configuration server 18 has the following
10   functions (1) to (4):

(1)   Upon receiving notification of the application-launch event from the event notifier 17, the configuration server 18 decides, based upon the event identifier "application" contained in event
15   notification, whether to perform control for bandwidth reservation. If bandwidth control is to be performed, the configuration server 18 uses the application identifier contained in the event notification as a key to query the directory server 16 as to the bandwidth
20   required by the application that has been launched at the end terminal, and obtains the response "1.5 Mbps" regarding this inquiry. In this embodiment, a response to the effect that the bandwidth is 1.5 Mbps is obtained when the directory server 16 is queried using the
25   application identifier "videoplayer" as the key.

(2)   Next, through a method similar to that of the first embodiment, the configuration server 18 uses the reported IP addresses of the client 11 and server 12 and

the IP routing information to specify the routers 14_1, 14_2 and the switches 15_1, 15_3, 15_4 that relay the sent and received traffic that occurs between the client 11 and the server 12. More specifically, the configuration

5   server 18 identifies the network devices (routers and switches) on the communication path CPT between the client 11 and server 12.

(3)   The configuration server 18 acquires information relating to each router (the states of the

10   routers and the configuration items) from the obtained IP addresses of the relaying routers.

(4)   On the basis of the router information and the bandwidth required by the application, the configuration server 18 generates a bandwidth control parameter to

15   configure the router and sets this parameter in the router that relays the communication between the client and the server. By repeating the above configuring for each router, the configuring of the bandwidth of all routers on the communication path from the client 11 to

20   the server 12 will eventually be completed. As a result, the bandwidth required by the application can be assured between the client and the server and communication can be performed at a high quality.

(c)   Bandwidth configuration sequence

25   Fig. 16 is a diagram useful in describing a bandwidth configuration sequence according to the fourth embodiment. This illustrates a case in which when the user has logged in from the client 11 and then launched

an application, the configuration server 18 uses

launching of the application as an event to perform

bandwidth configuration control of the routers 14_1, 14_2

on the communication path in accordance with the

5 required bandwidth set in advance for this application.

I. When the user having the user identifier

"fujitsu" logs in to the communication terminal (client)

11 having the IP address 192.169.10.20 (= IPc), the

client 11 sends the directory server 16 an LDAP message

10 for updating the information concerning the user

identifier "fujitsu". The LDAP message contains the

user identifier "fujitsu" and the IP address of the

client. Accordingly, the directory server 16 registers

the IP address of the client in association with the

15 user identifier "fujitsu" in the database (see Fig.

15B).

II. When the user having the user identifier

"fujitsu" launches a prescribed application at the

client 11 having the IP address IPc, this client sends

20 the directory server 16 an LDAP message in order to

register the application information. The LDAP message

contains, as application information, the application

identifier "videoplayer" for video reproduction launched

by the user having the user identifier "fujitsu", and

25 the IP address 192.168.30.11 (= IPa) of the video server

with which the application communicates. Accordingly,

the directory server 16 registers the application

identifier "videoplayer" and the IP address

192.168.30.11 (= IPa) of the server with which this application communicates in the database in association with the user identifier "fujitsu" (see Fig. 15C).

III. If the event notifier 17 within the directory
5 server 16 detects launching of the application, the event notifier 17 notifies the configuration server 18 of the fact that an application which has the application identifier "videoplayer" and which communicates with a video server having the IP address
10 IPa has been launched at the client 11 having the IP address IPc.

IV. The configuration server 18 queries, by LDAP, the directory server 16 in regard to the bandwidth required by the application using the application
15 identifier "videoplayer" as the key and obtains, as a response, the fact that the required bandwidth is 1.5 Mbps.

V. Next, on the basis of OSPF information, the configuration server 18 finds a router that relays the
20 communication between the client 11 and the server 12. Assume that the IP address of the one router 14_1 is "192.168.15.1 (= IPr)".

VI. The configuration server 18 obtains router information (state and information relating to the
25 configuration items) concerning the router 14_1. As a result, the router 14_1 can be configured using Telnet and the configuration server 18 can ascertain that this router is capable of having its bandwidth configured.

VII. The configuration server 18 performs Telnet
communication with respect to the router 14_1 of IP
address IPr and performs configuring to allocate the
bandwidth of 1.5 Mbps for communication for which the IP
5   address on the originating side is IPc and the IP
address at the destination is IPa.

VIII. The above-described allocating of bandwidth
is performed for other routers as well.

(d)   Modification

10   The fourth embodiment relates to a case where the
bandwidth required by an application is registered
beforehand in the application information field of the
directory server 16, as shown in Fig. 15A, the bandwidth
required by the application is obtained from this
15   registered data and is reported to the configuration
server. However, it is not necessary to register the
required bandwidth in advance. For example, an
arrangement may be adopted in which when an application
is launched, the required bandwidth is registered in the
20   user information field upon being sent to the directory
server 16 along with the application identifier and IP
address of the destination with which the application
communicates. Fig. 17 illustrates an example of the
database structure in directory server 16 in such case.
25   With this data structure, the configuration server 18 is
capable of querying the directory server 16 in regard to
required bandwidth using a combination of both the user
identifier and application identifier as a key.

Further, though the foregoing relates to a case in which bandwidth is controlled, control of packet discard rate and control of delay can be executed in the same manner. Further, an arrangement can be adopted in which

5   two or more types of control such as control of bandwidth, control of discard rate and control of data, inclusive of control of priority, can be performed simultaneously.

Further, the foregoing relates to a case in which

10   bandwidth required by an application is set in advance and the bandwidth of a router is controlled, in response to launching of the application, based upon the bandwidth required by this application. However, an arrangement can be adopted in which required bandwidth

15   is set for every user in advance and bandwidth is controlled, in response to launching of an application, based upon the bandwidth required by the user.

Further, the foregoing relates to a case where bandwidth, discard rate and delay are controlled by

20   launching an application. However, an arrangement can be adopted in which bandwidth, discard rate and delay are controlled by generating a log-in event.

Fig. 18 is a diagram useful in describing a sequence in a case where allocation of bandwidth to a

25   router on a communication path is performed based upon bandwidth required by a user at occurrence of a log-in event, and Figs. 19A, 19B are diagrams showing the structure of the directory server 16. As shown in Fig.

19A, a bandwidth (1.5 Mbps) required by a user and the
IP address of an important server communicated with in
dedicated fashion by the user have been registered in
association with a user identifier.

5   I.   When the user having the user identifier
"fujitsu" logs in to the communication terminal (client)
11 having the IP address 192.169.10.20 (= IPc), the
client 11 sends the directory server 16 an LDAP message
for updating the information concerning the user
10   identifier "fujitsu".   The LDAP message contains the
user identifier "fujitsu" and the IP address of the
client.   The directory server 16 registers the IP
address of the client in association with the user
identifier "fujitsu" in the database (see Fig. 19B).

15   II.   The event notifier 17 within the directory
server 16 detects log-in and notifies the configuration
server 18 of the fact that a user having the user
identifier "fujitsu" has logged in to the client 11
having the IP address IPc.

20   III.   The configuration server 18 queries the
directory server in regard to the required user
bandwidth by LDAP using the user identifier "fujitsu" as
the key and obtains, as a response, the fact that the
address of the server 12 is 192.168.20.30 (= IPa) and
25   that the required bandwidth is 1.5 Mbps.

IV.   Next, on the basis of OSPF information, the
configuration server 18 finds a router that relays the
communication between the client 11 and the server 12.

Assume that the IP address of the one router 14_1 is "192.168.15.1 (= IPr)".

V. The configuration server 18 obtains router information (state and information relating to the
5   configuration items) concerning the router 14_1. As a result, the router 14_1 can be configured using Telnet and the configuration server 18 can ascertain that this router is capable of having its bandwidth configured.

VI. The configuration server 18 performs Telnet
10   communication with respect to the router 14_1 of IP address IPr and performs configuring to allocate the bandwidth of 1.5 Mbps for communication for which the IP address on the originating side is IPc and the IP address at the destination is IPa.

15   VII. The above-described allocating of bandwidth is performed for other routers as well.

The foregoing is for a case where bandwidth is controlled. However, control of packet discard rate and control of delay can be performed in similar fashion.
20   Further, an arrangement can be adopted in which two or more types of control such as control of bandwidth, control of discard rate and control of data, inclusive of control of priority, can be performed simultaneously.

Thus, in accordance with the present invention, a
25   network device is found on a communication path connecting a communication terminal employed by a user and a server that is the destination with which this terminal communicates, and priority is controlled by

configuring priority information, which conforms to the priority of the user, for this network device. As a result, control of priority can be performed dynamically, without using a specific protocol such as

5   RSVP, even if there is a change in a terminal employed by a user or a change in network configuration due to the addition of a network device.

Further, in accordance with the present invention, communication can be performed between a terminal

10   employed by a user and a server, with which this terminal communicates, at a priority set for the user in advance. As a result, by setting a priority that takes the post of an employee and organization, etc., into account in an enterprise network, it is possible to

15   perform communication based upon priority control commensurate with the set priority.

Further, in accordance with the present invention, there is provided a database for storing, in association with a user identifier, user information that includes

20   the address of a server that is the destination of communication and the user priority. An event notification device acquires user priority and the server address from the database and reports these to a network-device controller. As a result, the user,

25   merely by entering the user identifier from a prescribed communication terminal and logging in, establishes a communication path between this communication terminal and the server with which the user wishes to

communicate. Communication between the terminal
employed by the user and the server can be performed at
the priority set for the user beforehand.

Further, in accordance with the present invention,
5   when an application is launched after user log-in, the
priority control mentioned above is carried out. As a
result, the configuring of priority control necessary
for the user in a network can be performed at a time
when priority control is required and with respect to a
10   device that requires control of priority.

Further, in accordance with the present invention,
a network device is found on a communication path
connecting a communication terminal employed by a user
and a server that is the destination with which this
15   terminal communicates, and priority is controlled by
configuring priority information, which conforms to the
priority of an application that has been launched, for
this network device. As a result, control of priority
can be performed dynamically, without using a specific
20   protocol such as RSVP, even if there is a change in a
terminal employed by a user or a change in network
configuration due to the addition of a network device.

Further, in accordance with the present invention,
communication can be performed between a terminal
25   employed by a user and a server, with which this
terminal communicates, at a priority set for an
application in advance. As a result, by configuring
priorities for various applications in an enterprise

network upon taking into account the urgency and importance of these applications, it is possible to perform communication based upon control of priority commensurate with the set priority.

5   Further, in accordance with the present invention, an event notification device acquires the priority of an application, the address of a server that is the destination of communication and the address of the communicating terminal from a database based upon the

10   application identifier and reports these to a network-device controller. As a result, the user, merely by entering a user identifier from a prescribed communication terminal, logging in and launching a prescribed application, establishes a communication path

15   between this communication terminal and the server that conforms to the application. Communication between the terminal employed by the user and the server can be performed at the priority set for the application beforehand.

20   Further, in accordance with the present invention, control of quality (bandwidth control, discard-rate control and delay control) can be performed dynamically without using a specific protocol even if there is a change in a terminal employed by a user or a change in

25   network configuration due to the addition of a network device. In addition, communication can be performed between a terminal employed by a user and a server, which is the destination of communication, at a quality

set for the user or application in advance.

    As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood

5 that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.